

SAN FRANCISCO BAY REGION
A REVIEW OF
GEOTECHNICAL
STUDY COSTS

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SAN FRANCISCO BAY REGION A REVIEW OF GEOTECHNICAL STUDY COSTS

PURPOSE

Information on the costs of geotechnical studies can help local governments evaluate how requirements for soils and geologic studies affect the cost and timing of new development. This information also can help determine if local governments are making the best use of the geotechnical services available to them. ABAG has surveyed the geotechnical firms in the region--the soils engineers and geologists that actually do the studies--to collect this information.

While this data is not specific enough to provide developers with information on what they will pay for studies on a particular parcel of land, it can be used to provide planners and elected officials with some idea of study costs in various broad categories of land. Discussion about the costs of these studies is not meant to diminish their value in reducing the damage associated with landslides and other natural hazards.

MAJOR CONCLUSIONS

The ABAG survey collected information on the costs of studies and, more important, on the factors that contribute to those costs:

- o Although larger companies charge more for their studies, they also tended to perform more types of studies for larger developments in more Bay Area counties.
- o The public review process can make a large difference in the cost of a study, yet many reported that it leads to better decisions. Survey participants disagreed on ways of lowering these costs.
- o The cost and difficulty of making a study on a single home site is proportionately much greater than for a subdivision or for a commercial or industrial development.
- o Costs depend on the area being studied. The total cost of a geotechnical study in a typical hillside area is much the same as one in lowland areas bordering the Bay. Cost in flat and gently sloping areas are less than hillside areas--ranging from 20% to 80%--and averaging 30%.

STUDY PROCEDURE

One page pre-surveys were mailed to all the firms advertising in Bay Area phone directories to obtain some basic information about the company and to give the respondents a choice of either filling out a written questionnaire or being interviewed. The written questionnaires asked for detailed information on charges for five different types of studies and what these charges depended on. The interview format elicited much additional information on what local governments could do to reduce the costs of studies while still getting the information required. A more complete description of the procedure and a list of survey participants is included at the end of this report.

GENERAL FINDINGS

FIRM SIZE

Larger companies tend to provide a greater variety of services and to work on larger developments in more areas than smaller companies. These tendencies, together with greater overhead, lead to greater costs.

The following charts summarize the relationship between firm size and type of studies performed (Table 1), type of development projects studied (Table 2) and number of counties in the region in which they do business (Table 3). The total number of firms responding varies from chart to chart since all firms did not answer all questions.

PUBLIC HEARINGS AND THE REVIEW PROCESS

Holding public hearings, filling out forms, and getting reports reviewed by staff may double the cost of a study. If the project is controversial, the cost may increase up to tenfold. The cost of the review process often depends on the jurisdiction's policies toward growth, not on the relative problems of the project. The competence of the person reviewing the report for the jurisdiction may affect the cost significantly.

As a result of these problems, the participants saw the need for a better mechanism to review reports. Some firms felt that the review process went most smoothly in jurisdictions with very rigid ordinances that specified the report requirements and minimized discretion of the particular person reviewing the report. Other firms felt that the review process worked best when the reviewing staff were able to make their comments flexible and bend them to the particular situation, rather than being bound by rigid ordinances. Several firms mentioned the need for full-time reviewers while

TABLE 1: RELATIONSHIP BETWEEN FIRM SIZE
AND VARIETY OF DEVELOPMENT STUDIES PREPARED

# of Types of Studies	1-2 Professionals	3-10 Professionals	11-30 Professionals	31-100+ Professionals
1	1	1	1	
2	5	2		
3	2	1		
4	4	5		
5	12	21	10	5

TABLE 2: RELATIONSHIP BETWEEN FIRM SIZE AND
NUMBER OF BAY AREA COUNTIES IN WHICH FIRM HAS WORKED

# of Bay Area Counties	1-2 Professionals	3-10 Professionals	11-30 Professionals	31-100+ Professionals
1	1			
2				
3	2	3		
4	3		1	
5	3	4		
6	2	3		
7	1	5	1	
8	5	7	1	1
9	5	8	10	4

TABLE 3: RELATIONSHIP BETWEEN FIRM SIZE
AND TYPES OF DEVELOPMENT ON WHICH
FIRM HAS WORKED

Type of development	1-2 Professionals	3-10 Professionals	11-30 Professionals	31-100+ Professionals
Single family home site*	20	29	9	5
Less than 1-acre subdivision	19	25	9	5
1-5 acre subdivision	18	28	9	5
5-20 acre subdivision	18	28	9	5
Greater than 20-acre subdivision	15	27	9	5
Apartment building site	19	28	9	5
Apartment complex site	15	29	9	5
Light industrial complex	16	27	9	5
Heavy industrial complex	8	17	9	5
Small commercial building (1-4 stories)	16	28	9	5
Regional shopping center	9	21	9	5
Large commercial building (greater than 4 stories)	7	22	8	5
Commercial re-development complex	6	17	7	5
Total answering questions	23	30	9	5

*The difference between these figures and those cited in the discussion of the single-family home site is that these figures are the numbers of firms that have performed studies for home sites, the earlier figures are the numbers of firms that are willing to perform these studies in the future.

others felt this was not needed, especially in smaller jurisdictions. Some firms believed that existing staff geologists should be supplemented with staff soils engineers. They felt that developers would save money by paying a fee for formal soils engineering review, rather than relying on a geologist to review soils engineering reports. Some felt that the most important savings could be realized if a list of reviewing staff or contact people in jurisdictions could be developed.

Several companies indicated that there was a definite need to develop more standardized regulations among jurisdictions in the Bay Area. These firms did not believe, however, that the State should establish the regulations since the type of development in the Los Angeles area warrants a different set of requirements than in the Bay Area. Any State regulations would need to be sensitive to local conditions.

The requirement for Environmental Impact Reports has had an effect on the process of preparing a geotechnical study in some areas. Some companies help write the geologic and soils portions of these reports. An early feasibility study can often be used in the EIR and save the developer money. However if the portion of the EIR on soils and geology is written by a non-professional, the developer may pay more money in the final analysis by having to pay a geotechnical firm to attend meetings and to support and supplement the work. The earlier the feasibility study is made, the more valuable it becomes, especially if it is made when the potential developer has an option on the property but before it actually has been purchased.

STUDIES FOR SINGLE HOMES

Some local governments require studies for all developments, even a single house. This requirement has traditionally been very controversial. The study for a single home site is different than for a subdivision or for a commercial or industrial development. The investigation is especially difficult because the surrounding area may be built up and surface exposures of underlying materials insufficient. More subsurface work usually needs to be done and access is often difficult. All of these problems lead to more expense. The costs cannot be split between several home buyers as in subdivisions or taken up by savings in construction costs as for large buildings. The cost leads to excessive pressures on the geotechnical firm to make shortcuts when they are least feasible. This tactic leads to foundation failures, lawsuits, and corresponding increases in insurance costs. Needless to say, many firms will not perform a geotechnical study for a single house. Yet others will. The pre-survey indicated that fifty out of seventy firms will do such a study. Reasons for their willingness were quite similar:

- o The firm believes it is its public duty to perform a service and, since there is a need, they perform the studies.
- o The firm is selective about the areas in which it does the studies and only does them in areas where the principals of the firm are very familiar with the soils and geologic conditions.

- o The firms are selective about the construction companies or architects with which they do business.
- o Many are small companies that do not have the overhead of larger firms and have principals in the company which can afford to spend time on small projects.
- o Some of the firms actually specialize in problem lots and these are largely single residential lots.
- o Firms are usually careful to tell the owner what they are getting into beforehand to ensure that they are able to perform an adequate job.
- o Some of these firms bypass the insurance problem by not having insurance. They view insurance as a license to cut costs and do unacceptable work.

FINDINGS RELATED TO SPECIFIC STUDY REQUIREMENTS

COSTS OF FAULT STUDIES IN ALQUIST-PRIOLO SPECIAL STUDIES ZONES

Many factors contribute to the cost of the study required by the Alquist-Priolo Special Studies Zones Act. The factors mentioned and the number of firms mentioning each factor are listed in Table 4, below. The first three factors are specifically mentioned as possibilities in the survey.

An attempt was made to quantify the effect of the type and size of the proposed development on the total cost of the study; firms were asked to estimate the cost of the preliminary and detailed investigations for 13 hypothetical developments. The costs varied widely. Large ranges were given by many firms. Firms that refused to provide estimates noted that developers might be misled into thinking that the cost of a study would be a set amount and that they would be angry if their particular study cost more than the set amount. The costs did help clarify the relationship among parcel size, type of development, and study cost. The range and mean range for each hypothetical development are given in Table 5, below.

TABLE 4: FACTORS CONTRIBUTING TO THE COST
OF STUDIES IN ALQUIST-PRIOLO STUDY ZONES

Factor	# of Firms Listing the Factor
The cost of a preliminary investigation depends, in part, on whether or not a detailed investiga- tion will be required.	11/33
The cost depends on the type of development proposed (type of buildings and size of parcel)	25/33
The cost depends on the number of similar studies performed in adjoining areas	23/33
The cost depends on other factors including	
o how complicated the faulting is in the area (San Mateo vs. Marin vs. Santa Clara)	16
o access (including topography)	6
o the shape of the parcel	4
o availability of aerial photos	4
o availability of published geologic mapping	4
o the amount of trenching required	3
o extent of existing development	2
o if the site is in the central portion of the zone or on the border	2
o activity of the fault	1
o type of soil conditions, including liquefiable conditions and Bay muds	1

TABLE 5: COST OF FAULT STUDIES REQUIRED IN
ALQUIST-PRIOLO SPECIAL STUDIES ZONES

Development	Approximate Cost in Dollars			
	Preliminary Investigation		Detailed Investigation	
	Range	Mean Range	Range	Mean Range
(1) 20-acre single-family home subdivision to be divided into 100 lots of 1/5 acre each.	\$200-300	\$1,181-1,336	\$1,500-25,000	\$6,333-11,298
(2) 5-acre single-family home subdivision to be divided into 25 lots of 1/5 acre each.	\$200-2,000	\$ 829-1,006	\$1,500-20,000	\$3,678-6,822
(3) 2/5-acre single-family home site to be divided into 2 lots of 1/5 acre each.	\$150-1,275	\$ 517-621	\$ 500-6,100	\$1,647-2,287
(4) 1 single-family home site of 1/5 acre.	\$150-1,200	\$ 433-550	\$ 700-5,600	\$1,692-2,200
(5) 20-acre single-family home subdivision to be divided into 4 lots of 5 acres each.	\$200,3000	\$ 955-1,092	\$1,200-18,000	\$3,992-6,010
(6) 1 single-family home site of 5 acres.	\$100-1,250	\$ 436-529	\$ 700-5,000	\$1,780-2,220
(7) 1-single family home site of 40 acres.	\$100-1,600	\$ 578-678	\$ 100-10,000	\$2,070-3,110
(8) 5-acre apartment complex (3 story).	\$200-2,000	\$ 980-1,500	\$1,500-20,000	\$3,950-6,140
(9) An apartment on 2/5 acre (3 story).	\$200-1,500	\$ 760-900	\$ 700-200,00	\$2,270-3,870
(10) 50-75 acre regional shopping center complex.	\$500-7,000	\$2,010-2,130	\$21,000-50,000	\$9,540-13,080
(11) 300-350 acre light industrial complex.	\$200-10,000	\$2,020-2,190	\$9,500-150,000	\$9,160-20,790
(12) Downtown commercial redevelopment project (3 stories) of 5 acres.	\$500-5,000	\$1,900-2,030	\$2,000-25,000	\$6,650-9,650
(13) A commercial building on 2/5 acre (3 stories).	\$100-2,000	\$ 840-950	\$ 700-20,000	\$2,780-4,490

Next, an attempt was made to determine the cost of a study if a previous study had been made on the same fault (at distances ranging from adjacent parcels to one mile away). Table 6, below, summarizes the results.

TABLE 6: COST OF FAULT STUDY IF PREVIOUS STUDIES MADE ON SAME FAULT

Distance From Previous Study	Cost		
	Increase	Decrease	No Change
1 mile away	0/28*	4/28 (small)	24/28
$\frac{1}{4}$ mile away	0/27	11/28 (~10%)	16/27
On an adjoining parcel	0/28	22/28 (~20%)	6/28

The amount of decrease depends on who performed the original investigation, whether or not a fault was found, and the complexity of the faulting.

In an attempt to determine how many preliminary investigations are likely to result in detailed investigations, participants were asked what relationship exists between photo-interpreted lineations and actual active faults. The range given varies widely (e.g., from 0-100% of lineations can be active faults) depending on the fault system in question and the photo interpretation techniques used.

During the process of answering these questions, survey respondents expressed a concern about some local governments attempting to reduce the costs by only requiring studies in the vicinity of the dashed line in the center of the study zones for single homes or minor subdivisions. According to both the firms and the California Division of Mines and Geology, a fault could be anywhere in the study zone. That is why the study zones were established in the first place. Firms were also disturbed that so little effort had been made to update the maps periodically as new and better information was received resulting in costly studies being required in unhazardous areas. Unfortunately, the CDMG staff and the staff reviewing the studies for local governments do not have the time to update the maps.

COSTS OF SLOPE STABILITY STUDIES

Many of the same factors contribute to the cost of the study required by many local governments in hillside areas. The factors mentioned and the number of firms mentioning each factor are listed in Table 7, below. The first three factors listed are specifically mentioned as possibilities in the survey.

*0/28 means zero out of 28 responding.

TABLE 7: FACTORS CONTRIBUTING TO THE COST OF STUDIES RELATED TO SLOPE STABILITY

Factor	# of Firms Listing the Factor
The cost depends on the number of acres in the parcel	36/38
The cost depends on the type of development proposed (height, cost, density and floor area)	29/38
The cost depends on whether or not a fault study is also required	19/38 (who does it? 1/38)
The cost depends on other factors including:	
o the location of the project	6
o the amount of landsliding	5
o the geologic materials, including their complexity	4
o the amount of grading proposed	3
o the depth or size of the slide(s) or potential slide(s)	3
o the topography	3
o the access	2
o the drainage	1
o the evidence for landsliding	1
o if the underlying geologic materials are exposed	1
o if other studies have been done in the area	1
o the amount of vegetation	1
o the extent of inspection required	1
o distance from the office	1
o activity of the fault	4
o type of soil conditions, including liquefiable conditions and Bay muds	1

In order to get a better knowledge of the relationship between geologic materials and topography, and study costs, survey participants were asked to estimate the amount of work required for each of five categories on 2 USGS maps (Nilsen, in press). The map shows five categories of relative slope stability. Table 8, below, summarizes the responses.

TABLE 8: RELATIONSHIP BETWEEN GEOLOGIC MATERIALS
AND TOPOGRAPHY AND EXTENT OF STUDY REQUIRED

Slope Stability Category	Percent of Preliminary Studies that Indicate Subsurface Reconnaissance Work is Required	Percent of Subsurface Investigations that Indicate Detailed Investigations are Required
1. Slopes less than 5%	--	--
2. Slopes between 5% and 15%	range = 40-100% mean = 47%	range = 0-100% mean = 41%
3. Slopes greater than 15% of geologic materials that are characteristically stable	range = 20-100% mean = 58%	range = 0-100% mean = 47%
4. Slopes greater than 15% of geologic materials that are characteristically unstable	range = 30-100% mean = 83%	range = 20-100% mean = 78%
5. Areas of photo-interpreted landslides, regardless of percent slope or materials	range = 50-100% mean = 92%	range = 50-100% mean = 87%

Only 16 of 38 firms answered this question. Three more noted that although they felt a correlation existed, they could not quantify it. Two firms noted that they did not understand the question.

Next, firms were asked to estimate the cost of preliminary investigations, subsurface reconnaissance and detailed investigations for thirteen hypothetical developments. The cost information helps to clarify the relationship among parcel size, type of development and study cost. The range and mean range for each hypothetical development are given in Table 9, following. (Since several firms gave a combined cost for a subsurface reconnaissance and a detailed investigation, those costs are given in a separate column.)

TABLE 9: COST OF SLOPE STABILITY STUDIES

Development	APPROXIMATE COST IN DOLLARS			
	Preliminary Investigation	Detailed Investigation	Combined Subsurface Reconnaissance and Detailed Investigation	Detailed Investigation
	(Mean) Min. - Max.	(Mean) Min. - Max.	(Mean) Min. - Max.	(Mean) Min. - Max.
(1) 20-acre single-family home subdivision to be divided into 100 lots of 1/5 acre each.	(\$117) \$200 - 3,000	(\$3,557) \$1,000 - 10,000	(\$11,506) \$1,000 - 50,000	(\$6,291) \$2,000 - 15,000
(2) 5-acre single-family home subdivision to be divided into 25 lots of 1/5 acre each.	(\$746) \$300 - 1,200	(\$1,957) \$ 700 - 4,000	(\$3,780) \$1,800 - 10,000	(\$3,058) \$1,000 - 5,000
(3) 2/5-acre single-family home subdivision to be divided into 2 lots of 1/5 acre each.	(\$426) \$150 - 700	(\$1,470) \$1,000 - 2,500	(\$1,595) \$ 500 - 3,000	(\$2,787) \$1,500 - 4,000
(4) 1 single-family home site of 1/5 acre.	(\$338) \$150 - 500	(\$1,050) \$ 600 - 18,000	(\$1,345) \$ 300 - 3,000	(\$1,860) \$ 600 - 4,000
(5) 20-acre single-family home subdivision to be divided into 4 lots of 5 acres each.	(\$871) \$200 - 3,000	(\$2,943) \$1,000 - 10,000	(\$4,272) \$1,000 - 15,000	(\$3,875) \$1,000 - 6,000
(6) 1 single-family home site of 5 acres	(\$527) \$150 - 2,000	(\$1,207) \$ 600 - 2,500	(\$2,179) \$ 300 - 4,000	(\$2,433) \$ 600 - 4,000
(7) 1 single-family home site of 40 acres	(\$747) \$150 - 4,000	(\$1,350) \$ 600 - 3,000	(\$3,600) \$ 300 - 25,000	(\$2,600) \$ 600 - 5,000
(8) 5-acre apartment complex (3 story)	(\$742) \$200 - 2,000	(\$3,281) \$1,000 - 10,000	(\$3,638) \$1,500 - 10,000	(\$4,750) \$2,000 - 10,000
(9) An apartment of 2/5 acre (3 story)	(\$554) \$150 - 1,000	(\$1,564) \$ 600 - 2,500	(\$1,905) \$ 800 - 3,000	(\$3,400) \$ 900 - 8,000
(10) 50-75 acre regional shopping center complex (2-3 stories)	(\$1,973) \$300 - 7,000	(\$4,440) \$2,000 - 8,000	(\$28,375) \$3,000 - 60,000	(\$9,000) \$7,000 - 12,000
(11) 300-500 acre light industrial complex	(\$2,186) \$300 -10,000	(\$8,143) \$2,000 - 18,000	(\$50,339) \$3,650 -150,000	(\$13,583) \$7,000 - 25,000
(12) Downtown commercial redevelopment project (3 stories) of 5 acres	(\$1,342) \$200 - 5,000	(\$7,000) \$1,000 - 10,000	(\$9,488) \$ 850 - 25,000	(\$8,000) \$4,000 - 15,000
(13) A commercial building on 2/5 acre (3 stories)	(\$600) \$150 - 800	(\$1,979) \$1,000 - 3,000	(\$2,682) \$ 800 - 7,000	(\$3,333) \$1,000 - 6,000

Next, firms were asked how much the cost of the preliminary work for slope stability would be reduced if preliminary work had already been completed for a surface rupture investigation. Five out of 27 said that the costs would not be reduced; seven out of 27 said no further preliminary work would be needed, so the preliminary work for slope stability would be essentially free; fifteen out of 27 felt that the cost would be reduced by 25-90%, or by an average of approximately 60%.

If site conditions necessitated a detailed investigation, then special engineering recommendations will probably result and additional costs would be incurred for special construction. This occurs from 20-100 percent of the time, or for an average of approximately 60% of the time.

Firms indicated that the results of a detailed investigation would suggest that a building could not be constructed on a site for an economically viable cost about 10% of the time. The cost of special mitigation can increase the cost of construction up to 2,000%, but is usually about a 20% increase. Other comments on the cost of mitigating slope stability problems included:

- o Feasibility studies prior to purchasing hillside property are highly recommended. They usually cost from \$100 to \$500 depending on the kind of information desired and are a worthwhile investment.
- o The loss of buildable land is also a cost to the developer.
- o It's much cheaper to deal with slope stability problems before construction than after failure. For example, \$5,000 in foundation work can become \$35,000 in corrective foundation work.
- o Developers of large projects can afford more mitigation than developers of small projects.
- o People are more willing to spend money to save existing buildings than to prevent problems.
- o Mitigation costs are related to the designer's qualifications.
- o Mitigation costs depend on the area in which the project is located.

COSTS OF EXPANSIVE SOILS STUDIES

Tests for expansive soils are normally performed as part of a required soils report.

The only commonly available maps that depict this problem are standard soil maps produced by the Soil Conservation Service. Although a few firms felt that these maps might be useful for general planning purposes, most

felt that the maps could not be used to predict the amount of corrective work needed. They tended to rely more on past experience to predict the corrective work needed.

Two-thirds of the firms felt that the cost of correcting shrink-swell problems was higher on hillsides. One-third noted that the mitigation costs were no higher than might normally occur on hillsides, largely since the type of foundations commonly used on hillsides were inherently resistant to expansive soil problems.

COSTS OF LIQUEFACTION STUDIES

Studies to determine whether or not liquefaction potential may be a problem usually can be performed as part of a soils investigation without the use of additional borings. Much of the time the borings need to be deeper, however.

Soils companies perform this type of initial investigation routinely as part of a soils report in most valley and Bay mud areas. The more complicated liquefaction tests for design and response are not normally performed, however.

Again, many factors contribute to the cost of these types of studies. The factors mentioned and the number of firms mentioning each factor are listed in Table 10, below. The first two factors are specifically mentioned as possibilities in the survey.

TABLE 10: FACTORS CONTRIBUTING TO
THE COST OF LIQUEFACTION STUDIES

Factor	# of Firms Listing the Factor
The cost of the study depends on the number of acres in the parcel.	24/30
The cost of the study depends on the type of development proposed.	21/30
The cost of the study depends on other factors including:	
o Local soil conditions	10
o The depth of the water table	6
o The level of mitigation required	4
o If a school or hospital is to be built at the site	2
o The complexity of the subsurface soils	2
o The ground rules	1
o The depth of the liquefiable materials	1
o The type of mud	1
o The thickness of liquefiable materials	1
o The magnitude of the design earthquake and the distance of the parcel from the fault	1
o The ease of obtaining samples	1

The cost range for these types of investigations vary widely. The investigation to determine whether or not a problem may exist usually ranges from \$200 - \$1,000, while a more complex investigation, including computer analyses, can range from \$20,000 - \$100,000. While some firms perform the more complicated analyses, others believe that the studies are virtually useless!

USGS has mapped 5 categories that are thought to be related to liquefaction potential in a general manner (Youd, et al., 1973). The categories have the following characteristics:

- Category 1: Tertiary and older deposits
- 2: Older (Pleistocene) alluvial fan deposits
- 3: Younger (Holocene) alluvial deposits
- 4: Younger (Holocene) alluvial deposits where the water table is normally within 10 feet of the surface
- 5: Deposits underlying young bay sediments.

The materials in the categories have the following characteristics:

	<u>% Materials Loose Enough for High. Liq. Poten.</u>	<u>% Materials Loose Enough for Marginal Liq. Po.</u>	<u>% Materials Not Loose Enough to Have Have Signif. Liq. Po.</u>
Category 1	0%	0%	100%
Category 2	11%	29%	60%
Category 3	22%	33%	45%
Category 4	22%	33%	45%
Category 5	33%	28%	39%

USGS defines those sediments likely to liquefy in a moderate earthquake (magnitude 6.5) as having a "high" liquefaction potential. Those sediments unlikely to liquefy in even a large event (magnitude 8.0) are defined as not having significant liquefaction potential. The marginal liquefaction potential designation indicates that the materials are intermediate between high and low potential.

The firms were asked to estimate, for each of these categories, the percentage of studies that probably would indicate mitigation. These estimates, made by only seven firms, varied so much as to be of no use. Three of the seven estimated that fewer projects would need mitigation in category 5 than category 4, in spite of the data given on looseness of materials!

Next, firms were asked to estimate how the cost of mitigation work might be related to increases in construction costs. Eleven of eighteen firms disagreed with this method of estimating costs, although none could provide a better method. The ranges of increases were again too varied to be of much use. Mitigation costs are apparently extremely dependent on each particular project.

COSTS OF SETTLEMENT STUDIES

Studies on settlement potential are performed as part of a required soils report, if needed. Apparently they are only felt to be needed an average of 40% of the time.

The cost of such a study depends on a number of factors, listed in Table 11, below.

TABLE 11: FACTORS CONTRIBUTING
TO THE COST OF SETTLEMENT STUDIES

Factor	# of Firms Listing the Factor
The cost of the study depends on the number of acres in the parcel.	23/29
The cost of the study depends on the type of development proposed (including the load of the buildings)	25/29
The cost of the study depends on other factors including:	
o Local soils or geologic conditions	10
o The thickness of the compressible soils	3
o The design of the building	3
o The water table	2
o The cost of the project	1
o The time required to prepare the report	1
o The amount of monitoring required after construction	1
o Access	1
o The point in time at which the soils engineer enters the project	1
o The foundations and earthwork proposed	1
o The number of samples tested	1

Next an attempt was made to try to predict, for planning purposes, the extent of special engineering and foundation work required for four map-pable categories:

- 1: Bay muds
- 2: Slopes greater than 15%
- 3: 5% - 15% slopes
- 4: All other areas.

The firms felt these categories to be sloppy. One firm suggested the following categories:

- 1: Bay mud and peat soils
- 2: Fills
- 3: Low density soils
- 4: Thick colluvium

The cost of extra study in areas of settlement might add from \$200 - \$1000 to the cost of a typical soils investigation. Although the cost of mitigation may be substantial, the problem land usually costs less; therefore, the total cost of development ends up being about the same as on problem-free land.

HOW THIS INFORMATION WAS COLLECTED

COMPILING A MAILING LIST

A list of geotechnical firms that do business in the Bay Area was obtained by compiling a list from the yellow pages of Bay Area telephone books under the categories "engineers-foundation" and "geologist." Names were obtained for 118 firms.

SENDING OUT A PRE-SURVEY

A one-page survey was then mailed to these addresses to:

- o get the name of a contact person for sending future information
- o determine whether the firm would be willing to participate in such a survey
- o give the respondent a choice of filling out a written questionnaire or being interviewed
- o obtain some basic information about the company: its size, the type of studies performed, the types of development studied, and the counties in which it does business.

Of the original 118 pre-surveys that were mailed, eleven were returned by the post office because the company was no longer at the address listed and had left no forwarding address. Five companies were listed under two names. Eleven companies indicated that they did not perform the type of services listed; most emphasized hydrogeology (largely well-drilling services) or did resource and mining exploration work. Only 21 surveys were not returned. Most of these had been sent to individuals, not companies. Eight firms were unwilling to participate. Sixty-two firms indicated that they would be willing to participate. Of these, 28 preferred filling out a written questionnaire, while 23 preferred being interviewed. The eleven respondents that did not indicate a preference were sent written questionnaires.

COMPILING AND ANALYZING THE WRITTEN QUESTIONNAIRES

The written questionnaires asked very specific questions about charges for five different types of studies and what these charges depended on. Although questions left much room for comment, few responded about general problems with the way local governments are using available geotechnical services. The emphasis of the responses was on hard data. Sixteen of the 41 firms sent written questionnaires did not return them, probably because they were quite long.

CONDUCTING INTERVIEWS

The interview format lead to a different type of response. Although information was collected on general costs, much additional information was collected on what local governments could do to improve the study process.

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